

WHAT IS CLAIMED IS:

1. A device for measuring the flow rate of a substantially continuous fluid flow comprising
a conduit for transporting in a selected direction a continuous fluid flow varying in height up to a maximum height wherein said maximum height is less than the height which would occlude said conduit;

a detector positioned relative to said conduit for determining the height of a selected section of said substantially continuous fluid flow at a first predetermined location and for determining at a second predetermined location located in a selected direction and a known distance from said first predetermined location that said selected section of said continuous fluid flow has traversed from said first predetermined location to said second predetermined location; and

a processing device operatively connected to said detector for deriving the cross-sectional area of said selected section of the substantially continuous fluid flow from said height of a selected section determined by said detector at said first predetermined location, determining an elapsed time for the

selected section of said continuous fluid flow to transverse said known distance and for calculating therefrom the fluid flow of said substantially continuous fluid flow through said conduit.

2. The device of claim 1 wherein said detector has a first detection section for determining at said first predetermined location the height of said selected section of said continuous fluid flow and a second detection section for determining the height of said selected section of said continuous fluid flow at said second predetermined location.

3. The device of claim 2 wherein said first detection section and said second detection section are located within said conduit, said first detection section comprising a first sensor having a predetermined cross-sectional area defining an opening for passing said fluid flow therethrough wherein said predetermined cross-sectional area is greater than the cross-sectional area of said fluid flow passing therethrough and wherein said second detection section comprises a second sensor having a cross-sectional area substantially equal to the cross-sectional area of the first sensor.

4. A device for measuring the flow rate of a substantially continuous fluid flow comprising

a conduit for transporting in a selected direction a substantially continuous fluid flow varying in height up to a maximum height wherein said maximum height is less than the height which would occlude said conduit;

a first detector positioned relative to said conduit for determining at a first predetermined location the height of a selected section of said continuous fluid flow; and

a second detector positioned relative to said conduit and said first detector for determining at a second predetermined location located in the selected direction and a known distance from said first predetermined location that the selected section of said continuous fluid flow has traversed said known distance; and

a processing device operatively connected to said first detector and said second detector for deriving the cross-sectional area of said selected section of the substantially continuous fluid from the height of a selected section at said first predetermined location, for determining an elapsed time for the selected section of said substantially continuous fluid

flow to traverse said known distance and for calculating therefrom the fluid flow of said substantially continuous fluid flow through said conduit.

5. The fluid flow device of claim 4 wherein said first detector and said second detector are laser measuring devices for determining the heights of said selected section of said substantially continuous fluid flow at said first predetermined location and said second predetermined location.

6. The fluid flow device of claim 4 wherein said first detector and said second detector are ultrasound measuring devices for determining the heights of said selected section of said substantially continuous fluid flow at said first predetermined location and said second predetermined location.

7. The fluid flow device of claim 4 wherein said first detector and said second detector are electromagnetic measuring devices for determining the heights of said selected section of said substantially continuous fluid flow at said first predetermined location and said second predetermined location.

8. The fluid flow device of claim 7 wherein said electromagnetic measuring devices include at least one hall effect transducer.

9. The fluid flow device of claim 4 wherein said first detector and said second detector are pressure measuring devices for determining the heights of said selected section of said substantially continuous fluid flow at said first predetermined location and said second predetermined location.

10. A fluid flow device comprising

a conduit for transporting in a selected direction an electrically conductive substantially continuous fluid flow varying in height up to a maximum height wherein said maximum height is less than the height which would occlude said conduit;

a first sensor having a predetermined cross-sectional area defining an opening for passing said fluid flow therethrough and being located at a first predetermined location within said conduit, said predetermined cross-sectional area being greater than the cross-sectional area of said fluid flow passing therethrough, said first sensor being operative to determine the height of a selected section of said substantially continuous fluid flow at said first predetermined location as a function of that portion of said predetermined section of said first sensor enclosed by the selected section of said continuous fluid flow at said first predetermined location; and

09782849 "071301
T E T 2 0 " 6 4 8 2 8 4 9
a second sensor having a cross-sectional area substantially equal to the cross-sectional area of the first sensor and being positioned relative to said conduit and said first sensor and being operative to determine at a second predetermined location located in a selected direction and a known distance from said first predetermined location the height of the selected section of said substantially continuous fluid flow at said second predetermined location as a function of that portion of said predetermined cross-sectional area of said second sensor enclosed by the selected section of said substantially continuous fluid flow at said second predetermined location.

11. The fluid flow device of claim 10 further comprising a conductivity sensor located within said conduit and positioned to be in substantially continual contact with said substantially continuous fluid flow for measuring the conductivity of said electrically conductive continuous fluid flow.

12. The fluid flow device of claim 11 further comprising a processing device operatively connected to said first sensor, said second sensor and said conductivity sensor for deriving the cross-sectional area of said electrically conductive continuous fluid flow from the height of the selected

section of said substantially continuous fluid flow determined by said first sensor, determining an elapsed time for the selected section of said continuous fluid flow to traverse said known distance between said first sensor and said second sensor and for calculating therefrom the fluid flow of the substantially continuous fluid flow through said conduit compensated for variances of fluid conductivity measured by said conductivity sensor.

13. The fluid flow device of claim 10 wherein said first sensor is a pair of spaced, coaxially aligned rings.

14. The fluid flow device of claim 13 wherein said second sensor is a pair of spaced, coaxially aligned rings.

15. The fluid flow device of claim 14 wherein said first sensor pair of spaced, coaxially aligned rings have a selected diameter and wherein said second sensor comprise a pair of spaced, coaxially aligned rings having a diameter substantially equal to said selected diameter.

16. The fluid flow device of claim 15 wherein said conduit has an internal diameter and said selected diameter is substantially equal to the internal diameter of said conduit.

17. The fluid flow device of claim 11 wherein said conductivity sensor is located proximate at least one of said first sensor and second sensor.

18. The fluid flow device of claim 12 wherein said processing device further includes

an integrating device for determining an average height of a plurality of selected sections of said substantially continuous fluid flow and an average conductivity of said fluid flow;

a conductivity compensating device operatively connected to said integrating device for determining variances in conductivity of the electrically conductive fluid forming the fluid flow; and

a generator responsive to the integrating device for generating an output signal representing the fluid flow compensated for variances in conductivity.

19. A milk flow device comprising

a conduit for transporting in a selected direction a continuous milk flow varying in height up to a maximum height within said conduit wherein said maximum height is less than the height which would occlude said conduit;

09782849-071301
a first sensor having a predetermined cross-sectional area defining an opening for passing a milk flow therethrough and being located at a predetermined location in said conduit, said predetermined cross-sectional area being greater than the cross-sectional area of a milk flow passing therethrough for determining the height of a selected section of milk flow at said predetermined location as a function of that portion of said predetermined cross-sectional area enclosed by the selected section of the continuous milk flow at said predetermined location and conductivity of milk; and

a second sensor having a cross-sectional area substantially equal to the cross-sectional area of the first sensor and being spaced within said conduit in a selected direction and a known distance from first sensor for determining the height of said selected section of the continuous milk flow at said known distance as a function of that portion of said predetermined cross-sectional area enclosed by the selected section of the continuous milk flow at said known distance and conductivity of milk.

20. The milk flow device of claim 19 further comprising a conductivity sensor positioned to be in substantially continual contact with said continuous milk flow for measuring conductivity of said milk.

21. The milk flow device of claim 20 further comprising a processing device operatively connected to said first sensor, said second sensor and said conductivity sensor for deriving the cross-sectional area of a said milk flow from the height of said selected section of the milk flow as determined by said first sensor, determining an elapsed time for said selected section of the milk flow to traverse said known distance between said first sensor and said second sensor and for calculating milk flow through said conduit based on area of said fluid flow and elapsed time of said selected section of milk flow over said known distance compensated for variances of milk conductivity measured by said conductivity sensor.

22. The milk flow device of claim 21 wherein said first sensor is a pair of spaced, coaxially aligned rings.

23. The milk flow device of claim 22 wherein said second sensor is a pair of spaced, coaxially aligned rings.

09782849-071301
TDE720-64828260

24. The milk flow device of claim 22 wherein said first sensor pair of spaced, coaxially aligned rings have a selected diameter and wherein said second sensor comprises a pair of spaced, coaxially aligned rings having a diameter substantially equal to said selected diameter.

25. The milk flow device of claim 24 wherein said conduit has an internal diameter and said selected diameter is substantially equal to the internal diameter of said conduit.

26. The milk flow device of claim 21 wherein said processing further includes

an integrating device for determining an average fluid flow height of a plurality of selected sections of milk flow and an average conductivity of said milk flow;

a conductivity compensating device operatively connected to said integrating device containing data representing variances in conductivity of the milk forming the milk flow; and

a generator responsive to the integrating device for generating an output signal representing the milk flow compensated for variances in milk conductivity developed from said conductivity compensating device.

27. The milk flow device of claim 26 wherein said processing device includes an output device responsive to said output signal for displaying milk flow in at least one of gallons per minute and total weight.

28. A milk flow meter comprising

a conduit for transporting in a selected direction assisted by gravity a milk flow which varies in height wherein the height of said milk flow is less than the height which would occlude said conduit;

a first sensor having a selected cross-sectional area located at a predetermined location within said conduit wherein said selected cross-sectional area of said first sensor is greater than the cross-sectional area of said selected cross-sectional area of the milk flow for determining the height of a selected section of milk flow passing at said predetermined location based on the portion of the cross-sectional area of said first sensor enclosed by the selected section;

a second sensor having a cross-sectional area substantially equal to the cross-sectional area of the first sensor and being spaced in said conduit in a selected direction and a known distance from first sensor for determining the

height of said selected section of the continuous milk flow at said known distance based on the portion of the cross-sectional area of said second sensor enclosed by the selected section; and

a conductivity sensor located within said conduit in the proximity of at least one of said first sensor and said second sensor and positioned to be in substantially continual contact with said milk flow for determining conductivity of said milk.

29. The milk flow meter of claim 28 further comprising a processing device operatively connected to said first sensor, said second sensor and said conductivity sensor for deriving the cross-sectional area of said milk flow from said height of said selected section of the continuous milk flow determined by said first sensor and an elapsed time for said selected section of the continuous milk flow to traverse said known distance and for deriving therefrom milk flow through said conduit independent of variances of milk conductivity.

30. The milk flow meter of claim 28 wherein said conduit has a predetermined geometrical shape and said first sensor is a pair of spaced, coaxially aligned electrodes having a geometrical shape which is at least one of a shape substantially

the same as said predetermined shape and a shape different than said predetermined shape.

31. The milk flow meter of claim 30 wherein said second sensor is a pair of spaced, coaxially aligned electrodes having a geometrical shape which is at least one of a shape substantially the same as said predetermined shape and a shape different than said predetermined shape.

32. The milk flow meter of claim 30 wherein the geometrical shape of at least one of said first sensor and said second sensor is a substantially circular shape.

33. The milk flow meter of claim 30 wherein the geometrical shape of at least one of said first sensor and said second sensor is a substantially oval shape.

34. The milk flow meter of claim 30 wherein the geometrical shape of at least one of said first sensor and said second sensor is a substantially triangular shape.

35. The milk flow meter of claim 30 wherein said the geometrical shape of at least one of said first sensor and said second sensor is a substantially rectangular shape.

36. The milk flow meter of claim 35 wherein said the substantially rectangular shape of at least one of said first sensor and said second sensor is a substantially square shape.

37. The milk flow meter of claim 30 wherein the geometrical shape of at least one of said first sensor and said second sensor is a substantially trapezoid shape.

38. The fluid flow device of claim 29 wherein said processing device further includes

an integrating device for determining an average fluid flow height of a plurality of selected sections of milk flow and an average conductivity of said milk flow;

a conductivity compensation device operatively connected to said integrating device for deriving data representing variances in conductivity of the electrically conductive fluid forming the milk flow; and

a generator responsive to the integrating device for generating an output signal representing the milk flow compensated for variance in fluid conductivity developed by said conductivity compensation device.

09782849-071301
FOETLO-64828260

39. A milk flow device adapted to be positioned between a milk claw and a pipe line comprising

a conduit positioned between a milk claw and a pipe line for transporting in a selected direction and at a selected slope so as to be enable gravity to assist a continuous milk flow varying in height up to a maximum height to be transported within said conduit and wherein said maximum height is less than the height which would occlude said conduit;

a first sensor having a predetermined cross-sectional area defining an opening for passing a milk flow therethrough and being located at a predetermined location in said conduit, said predetermined cross-sectional area being greater than the cross-sectional area of a milk flow passing therethrough for determining the height of a selected section of the continuous milk flow at said predetermined location as a function of that portion of said predetermined cross-sectional area enclosed by the selected section of a continuous milk flow at said predetermined location and the conductivity of milk; and

a second sensor having a cross-sectional area substantially equal to the cross-sectional area of the first sensor and being spaced in said conduit in said selected direction and a known

distance from first sensor for determining the height of said selected section of the continuous milk flow at said known distance as a function of that portion of said predetermined cross-sectional area enclosed by the selected section of said continuous milk flow at said known distance and the conductivity of milk.

40. The milk flow device of claim 39 further comprising a conductivity sensor located in said conduit and positioned to be in substantially continual contact with said continuous milk flow for measuring the conductivity of milk forming said milk flow in the proximity of said first sensor and second sensor.

41. The milk flow device of claim 40 further comprising a processing device operatively connected to said first sensor, said second sensor and said conductivity sensor for deriving the cross-sectional area of a said milk flow from said height of the selected section of the continuous milk flow determined by said first sensor, determining an elapsed time for said selected section of the continuous milk flow to traverse said known distance between said first sensor and said second sensor and for calculating therefrom a milk flow rate through

said conduit compensated for variances of milk conductivity measured by said conductivity sensor.

42. The milk flow device of Claim 39 wherein said selected slope relative to horizontal plane varies between about 5 degrees to about 85 degrees.

43. The milk flow device of Claim 42, wherein said selected slope varies between about 10 degrees to about 80 degrees.

44. The milk flow device of Claim 43 wherein said selected slope varies between about 20 degrees to about 60 degrees.

45. The milk flow device of Claim 44 wherein said selected slope is about 25 degrees to about 35 degrees.

46. A method for measuring the flow rate of a continuous fluid flow comprising

transporting within a conduit in a selected direction a continuous fluid flow varying in height up to a maximum height wherein said maximum height is less than the height which would occlude said conduit;

determining with a detector at a first predetermined location the height of a selected section of the continuous fluid flow at said first predetermined location and for

determining at a second predetermined location located in a selected direction and a known distance that said selected section of the continuous milk flow has traversed from said first predetermined location to said second predetermined location; and

deriving with a processing device operatively connected to said detector the cross-sectional area of said continuous fluid flow determined by said detector from said height of said selected section of the continuous milk flow at said first predetermined location, determining an elapsed time for the selected section of said continuous milk flow to traverse said known distance and calculating therefrom fluid flow rate of the continuous fluid flow through said conduit.

47. The method of claim 46 device wherein the step of determining with said detector includes said detector having a first detection section for determining at said first predetermined location the height of a said selected section of the continuous milk flow and a second detection section for determining the height of said selected section of the continuous milk flow low at said second predetermined location.

48. The method of claim 47 wherein said step of detecting includes the detector having a first detection section and said second detection section located within said conduit, said first detection section comprising a first sensor having a predetermined cross-sectional area defining an opening for passing a selected section of fluid flow therethrough wherein said predetermined cross-sectional area is greater than the cross-sectional area of said fluid flow passing therethrough and said second detection section comprising a second sensor having a cross-sectional area substantially equal to the cross-sectional area of the first sensor and being positioned relative to said conduit and said first sensor for determining the height of a said selected section of the continuous fluid flow at said second predetermined location.

49. A method for measuring the flow rate of a continuous fluid flow comprising

transporting in a selected direction within a conduit a continuous fluid flow varying in height up to a maximum height wherein said maximum height is less than the height which would occlude said conduit;

determining with a first detector positioned relative to said conduit at a first predetermined location the height of a selected section of the continuous fluid flow at said first predetermined location; and

determining with a second detector positioned relative to said conduit and said first detector at a second predetermined location located in a selected direction and a known distance from said first predetermined location the height of said selected section of the continuous fluid flow at said second predetermined location; and

deriving with a processing device operatively connected to said first detector and said second detector the cross-sectional area of said continuous fluid flow determined by said first detector from said height of said selected section of the continuous fluid flow at said first predetermined location, determining an elapsed time for said selected section of the continuous fluid flow to traverse said known distance between said first detector and said second detector and calculating therefrom fluid flow rate of the continuous fluid flow through said conduit.

50. A method of measuring milk flow in a conduit wherein the maximum height of said milk flow is less than a height which would occlude said conduit comprising the steps of:

sloping said conduit at an angle to have milk flow in a selected direction assisted by gravity;

measuring with a first sensor having a known cross-sectional area located at a predetermined location in said conduit the height of a selected section of a continuous milk flow at said predetermined location a cross-sectional area of said first sensor and conductivity of milk forming said milk flow wherein the cross-sectional area of the milk flow is less than said known cross-sectional area;

determining with a second sensor located in a selected direction and known distance from said first sensor wherein said second sensor has a cross-sectional area substantially equal to the known cross-sectional area of the first sensor that the selected section of said continuous milk flow has traversed said known distance as functions of based on the known cross-sectional area of said second sensor and conductivity of said milk;

09782849-071301

determining with a conductivity sensor located in said conduit and positioned in substantially continue contact with said milk flow conductivity of said milk; and

deriving with a processing device operatively connected to said first sensor, said second sensor and said conductivity sensor the cross-sectional area of said milk flow from said height of said selected section of the continuous milk flow determined by said first sensor and an elapsed time for said selected section of the continuous milk flow milk flow to traverse said known distance a milk flow rate through said conduit independent of variances of milk conductivity.

51. A system comprising

a conduit positioned between a milk claw and a pipe line for transporting in a selected direction at a selected slope to assist by gravity the passage of a continuous milk flow varying in height up to a maximum height within said conduit wherein said maximum height is less than the height which would occlude said conduit;

a first sensor having a predetermined cross-sectional area defining an opening for passing a milk flow therethrough and being located at a predetermined location in said conduit, said

predetermined cross-sectional area being greater than the cross-sectional area of a milk flow passing therethrough for determining the height of a selected section of a continuous milk flow at said predetermined location as a function of that portion of said predetermined cross-sectional area enclosed by the selected section if said continuous milk flow at said predetermined location and the conductivity of milk;

TOE 20 64828260
a second sensor having a cross-sectional area substantially equal to the cross-sectional area of the first sensor and being spaced in said conduit in the selected direction and a known distance from first sensor for determining the height of said selected section of the continuous milk flow at said known distance as a function of that portion of said predetermined cross-sectional area enclosed by the selected section of a said continuous milk flow at said known distance and the conductivity of milk;

a conductivity sensor located in said conduit and positioned to be in substantially continual contact with said continuous milk flow for measuring conductivity of milk forming said milk flow in the proximity of said first sensor and second sensor; and

TOEET 20 64828450

a processing device operatively connected to said first sensor, said second sensor and said conductivity sensor for deriving the cross-sectional area of a said milk flow from said height of said selected section of the continuous milk flow determined by said first sensor, determining an elapsed time for said selected section of the continuous milk flow to traverse said known distance between said first sensor and said second sensor and for calculating milk flow rate through said conduit based on integrating a selected number of selected sections of milk flow compensated for variances of milk conductivity measured by said conductivity sensor.

52. The system of Claim 51 further comprising
a receiving jar operatively coupled to said pipeline for collecting said milk.

53. The system of Claim 51 wherein said first sensor comprises a pair of spaced opposed rings.

54. The system of Claim 52 wherein said second sensor comprises a pair of spaced opposed rings.

55. A milk flow meter for a milking system comprising a conduit having side walls and a minimum internal diameter selected to be in the range of a minimum internal diameter of at least about 0.75 inches for maintaining at peak milk flow rates from a milking apparatus substantially uniform flow of milk therethrough and for concurrently providing a stable continuous vacuum in a vacuum channel between the flow of milk and the interior side walls of said conduit and a maximum internal diameter equal to about 1.5 times the minimum internal diameter.

56. A milk flow meter for use in a high production milking system to reduce milking time and fluctuations of vacuum levels in the milking system comprising

a conduit having side walls and a predetermined minimum internal diameter selected to be in the range of a minimum internal diameter of at least about 0.75 inches for maintaining at peak milk flow rates from a plurality of inflations operatively connected to the milk claw substantially uniform flow of milk therethrough and for providing a stable and continuous vacuum in a vacuum channel defined by the flow of milk and the interior side walls of said conduit and a maximum

09782845-071304
FOET 20" 64828260

internal diameter equal to about 1.5 times the minimum internal diameter.

57. A milk flow meter adapted to be operatively connected to a milking apparatus withdrawing milk from an animal's teats while applying a controlled vacuum in the range of about 11.5 inches of Hg to about 14.0 inches of Hg to the teats enabling the milk to be withdrawn therefrom at various milk flow rates up to a peak flow rate, said milk flow meter comprising

a conduit having side walls and a predetermined minimum internal diameter selected to be in the range of a minimum internal diameter of at least about 0.75 inches for maintaining at the various milk flow rates a substantially uniform flow of milk therethrough and for concurrently providing a stable continuous vacuum in a vacuum channel between the flow of milk and the interior side walls of said conduit and a maximum internal diameter equal to about 1.5 times the minimum internal diameter.

263 5576 claim new format